Plant Document Analysis

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End of Engineering Analysis Report

ENGINEERING SPECIFICATION ANALYSIS

Focus Area: Nozzle Load Analysis

Generated on November 21, 2025

ContextFocus area = Nozzle Load Analysis.

Section 1: Accepted Specifications for Evaluation of Nozzle Load Analysis

(These are items in the submitted document that correspond to industry-standard inputs/requirements used for nozzle/nozzle-load/piping stress analysis.)

• Codes and standards referenced for mechanical/pressure vessel and piping design: ASME Section VIII (pressure vessels), ASME Section I (boilers) and ANSI B31.3 (process piping) — (document: Sections 9.7.1, 9.7.5, 9.9.4, 9.7.1).

• Seismic design standard: IS 1893 (document: 7.2 Seismic Data).

• Piping stress / nozzle analysis software listed: Caesar, NOZZLEPRO, CAEPIPE (document: 5.2 Software list).

• Vessel/nozzle construction requirements: "Connections on pressure vessels shall be flanged, unless welded construction is preferred" (document: 9.7.1 Nozzles).

• Minimum nozzle sizes and miscellaneous nozzle provisions for heat exchangers and pressure vessels:

• Minimum nozzle size on pressure vessels: 1 1/2" (document: 9.7.4 Spheres and Bullets; 9.7.5 Nozzles).

• Heat exchanger miscellaneous nozzles: vent/drain 1 1/2" if not vented/drained from process nozzle; drain valve of adequate size (3" minimum) on cooling water supply downstream of isolation valve; multi-purpose connections (50 NB) on all process nozzles; 3/4" utility connection on inlet and outlet nozzles for hydrotest (document: 9.7.5 Nozzles).

• Vessel vent & drain nozzle sizing table (explicit sizing by vessel volume): vent up to 6 m3 = 1½"; vent above 6 m3 = 2"; drain up to 6 m3 = 1½"; drain 6.1–15 m3 = 2"; drain above 15

m3 = 3" (document: 9.7.1 Vessels — Vent/Drain table).

• Design pressure determination / margins for equipment (table of margins to be added to maximum operating pressure) — explicit numeric rules for translating maximum operating pressure to design pressure (document: 9.5.1 Table for margin to be added to internal pressure).

• Design temperature guidance: Design Temperature default = 28 °C plus coincidental temperature at design pressure; for temperatures beyond 343 °C use 14 °C plus coincidental temperature (document: 9.5.2).

• Minimum Design Metal Temperature (MDMT) rule: the most stringent of (minimum ambient – 5.6 °C) and (minimum operating – 5.6 °C); depressuring criterion note (document: 9.5.3).

• Vacuum design guidance: columns/vessels subjected to steam-out to be designed for at least half vacuum (0.5 kg/cm2 a); steam condensers/steam reboilers/condensate pots/direct steam injection designed for full vacuum (document: 9.5.4).

• Corrosion allowances relevant to thicknesses (affects nozzle load stiffness calculations if as-built thickness differs):

• Carbon steel / low alloy steel (up to 2¼% Cr): 3 mm (static equipment) (document: 9.6.1).

• Low alloy steel (above 2¼% Cr up to 9% Cr): 1.5 mm (document: 9.6.1).

• Cladding/overlay minimums: cladding 2 mm minimum; if cladded considered CA minimum 3 mm (document: 9.6.1).

• Process piping carbon steel mildly corrosive: 1.5 mm; moderately corrosive: 3 mm (document: 9.6.1 / Process Piping table).

• Heat exchanger tube and nozzle dimensional/minimum thickness data (relevant to stiffness/transmission of loads):

• Tube OD / min thickness for Carbon Steel/Low Alloy: 20 mm OD → 2 mm; 25 mm OD → 2.1 mm. Stainless Steel 20 mm → 1.6 mm; 25 mm → 2.0 mm (document: 9.7.5 Tube Specifications).

• Heat exchanger design requirement: low-pressure side must be designed for at least 10/13 times the design pressure of the high-pressure side (tube-rupture load consideration) (document: 9.7.5).

• Piping design standard statement: all process piping shall be as per ANSI B31.3 and steam/condensate/feed water lines per IBR/ANSI B31.3 as applicable (document: 9.9.4).

• Control-valve manifold and bypass provisions (block and bypass / isolation) and requirement for drain on control valves (3/4" drain) — relevant for nozzle boundary conditions when piping connects to control valves (document: 9.9.3 and 9.8.1).

• Instrumentation/nozzle tapping requirements: instruments shall have individual tappings from process lines (document: 9.8.1) — relevant when nozzle penetrations carry instrument connections.

• Stated requirement for spectacle blinds / battery-limit isolation valves and spade/spacer usage for larger lines — relevant for isolation/load cases (document: 9.3 Equipment isolation philosophy).

Section 2: Measurements Provided in Document

(Explicit numerical values in the document that can be used as inputs/criteria for nozzle load analysis where relevant)

• Wind data:

• Onshore facilities: 50 m/s 3-second gust at 10 m elevation (50-year return) (document: 7.2.1).

• Offshore operational mean hourly wind: 15 m/s at 10 m elevation (5-year return) (document: 7.2.1).

• Offshore extreme survival mean hourly wind: 33 m/s at 10 m elevation (500-year return) (document: 7.2.1).

• m/s wind speed for flare heat radiation determination (document: 7.2.1).

• Temperatures:

• Maximum recorded Dry Bulb Temperature (DBT): 48 °C (document: 7.2.2).

• Minimum recorded DBT: 3 °C (document: 7.2.2).

• Design Temperature (DBT) for Air Coolers: 41 °C (document: 7.2.2).

• Electrical Design Temperature outdoors: 43 °C; indoors: 40 °C; Design Surface Temperature: 65 °C (document: 7.2.2).

• Winterizing Temperature: 10 °C (document: 7.2.2).

• Low ambient design temperature: 7.5 °C (document: 7.2.2).

• Atmospheric pressure:

• Maximum: 1.034 kg/cm2 a; Normal/Average: 1.024 kg/cm2 a; Minimum: 1.003 kg/cm2 a (document: 7.2.5).

• Tide/sea levels (could affect nozzle boundary supports for marine equipment): Highest Astronomical Tide +6.15 m; Mean Sea Level +3.10 m; Lowest Astronomical Tide –0.30 m (document: 7.2.6).

• Seismic design directive (no numeric spectral values in this document): comply with IS 1893 (document: 7.2 Seismic Data).

• Design pressure margin table (numerical rules converting Max Operating Pressure to Design Pressure):

• Vacuum to 1.8 kg/cm2 g → design typically 3.5 kg/cm2 g.

• to 17.6 kg/cm2 g → Design = Max. Operating + 1.8 kg/cm2 g.

• to 35.2 kg/cm2 g → Design = Max. Operating × 1.1.

• to 70.3 kg/cm2 g → Design = Max. Operating + 3.5 kg/cm2 g.

• Over 70.3 kg/cm2 g → Design = Max. Operating × 1.05. (document: 9.5.1 table).

• Boiler feedwater battery-limit pressures and temperatures (relevant if nozzles connect to BFW systems):

• HHP BFW normal: 127.7 kg/cm2 g (design 163.2); temperature normal 121 °C, design 150 °C (document: Attachment 3 Boiler Feed Water table).

• HP BFW normal: 59.2 kg/cm2 g (design 78); MP BFW normal: 23.9 kg/cm2 g (design 33.8); LP BFW normal: 10.9 kg/cm2 g (design 17.6) (document: Attachment 3).

• Steam battery-limit pressures & temperatures (user battery limit targets):

• HHP Steam normal 106 kg/cm2 g, design 117; temperature normal 510 °C, design 540 °C (document: Attachment 3).

• HP Steam normal 42.2 kg/cm2 g, design 47.6; temp normal 383 °C, design 426 °C.

• MP Steam normal 16 kg/cm2 g, design 21.1; temp normal 232 °C, design 288 °C.

• LP Steam normal 4.1 kg/cm2 g, design 8.1; temp normal 158 °C, design 260 °C.

• Fuel gas battery-limit pressure/temperature examples:

• Fuel gas typical: Min 3.2 / Normal 3.9 / Max 4.6 kg/cm2 g; temperature normal 38 °C; design 120 °C (document: Attachment 3 Fuel Gas).

• PSA tail gas pressure min 2 kg/cm2 g note (document: Attachment 3).

• Instrument/plant air battery-limit pressures:

• Plant Air normal 7.7 kg/cm2 g; design 10; temp normal 40 °C (document: Attachment 3 Plant Air).

• Instrument Air normal 7 kg/cm2 g; design 10; temp normal 40 °C (document: Attachment 3).

• Nitrogen battery-limit pressures:

• High Pressure N2 normal ~13.7 kg/cm2 g; design 15.4 (document: Attachment 3).

• Low Pressure N2 normal ~7 kg/cm2 g; design 10.5 (document: Attachment 3).

• Cooling water typical supply/return temperatures and pressures (indicative):

• Cooling water supply temperature 32 °C, return 45 °C; supply pressure examples ~4.1/4.6 kg/cm2 g (document: Attachment 3 Cooling Water).

• Corrosion allowance numeric values (repeated from Section 1 as measurement values):

• Carbon steel static equipment: 3 mm; low alloy up to 9% Cr: 1.5 mm (document: 9.6.1).

• Vessel manway/nozzle sizing values (repeated as measurements):

• Manhole sizes: vessel dia 900–1500 mm → 20" NB; >1500 mm → 24" NB; minimum ID of manhole 20" (document: 9.7.1).

• Heat exchanger tube preferred lengths and tube OD minimums (document: 9.7.5 Tube Specifications; preferred lengths 6.0 m etc.) — explicit tube OD and thickness numbers provided in table (see Section 1).

• Heat exchanger vent/drain and hydrotest connections sizes (see Section 1 numeric values: 1½", 3", 50 NB, 3/4") (document: 9.7.5).

• Noise/specification: equipment noise shall not exceed 85 dBA at 1 m from skid edge (document: 7.2.10) — relevant for specifying attachments that may add mass but not directly nozzle load.

Section 3: Inputs and Additional Requirements from Client

(Items explicitly provided in the document as client inputs or items the document calls out as to-be-provided / to-be-firmed-up; and missing items relevant to carrying out a complete nozzle load analysis that the document does not provide)

• Project codes of precedence: Indian Government Statutory Rules, Requisition Data Sheets, Requisition & Specifications, RIL Project Procedures, International Codes (document: 5).

• Software to be used for piping stress/nozzle analysis: Caesar, NOZZLEPRO, CAEPIPE (document: 5.2).

• Directive to follow licensor / process datasheets for ISBL nozzle/data where applicable (document: 9.7.1, 9.5.2).

• Statement that OSBL designer / DEC shall ensure battery-limit pressures/temperatures are satisfied and that typical battery-limit numbers in Attachment 3 will be firmed up as design progresses (document: multiple Attachment 3 notes).

• Explicit statement that nozzle/connection types: flanged connections preferred; separate 2" nozzle for steam-out or utility connections (document: 9.7.1).

• Requirement to follow ANSI B31.3 for process piping, and IBR where applicable (document: 9.9.4 and elsewhere).

• Requirement that proven rating calculations to be used, documented and checked/verified (document: various sections).

• Requirement for spectacle blinds and isolation provisions at battery limits for certain line sizes and ratings (document: 9.3 Equipment isolation philosophy).

• "Typical battery limit pressures and temperatures are indicated in Attachment 3. These numbers will be firmed up as system design progresses." — battery-limit conditions are preliminary (Attachment 3 notes).

• "The data enclosed ... references other documents" and several areas are marked HOLD (Fuel gas system, Syn gas, Nitrogen system) — fuel/syn gas details pending (document: Holds and sections 8.10, 8.11, 8.15 marked HOLD).

• "Where no number has been provided in current revision, OSBL Designer shall populate the tables as design evolves." — explicit acknowledgement that many specific operating/data points are not yet provided (Attachment 3 header notes).

• Nozzle location coordinates, nozzle orientations, and as-built nozzle reinforcement/attachment details — not present in this document.

• As-built equipment weights, center-of-gravity, and gravity load paths for vessels/heat exchangers (mass and CG) — not provided.

• Detailed piping geometry (span lengths, routing, elevations) and connected piping line sizes/weights/materials for each nozzle — not provided in this document (piping specs exist elsewhere).

• Specific pipe/payload dead loads, insulation/saddles/attachments and thermal expansion allowable displacements for each connected line — not provided.

• Detailed transient load cases (e.g., waterhammer events, relief valve discharge backpressure combinations) and expected internal pressure transients for nozzle load combinations — not provided.

• Detailed seismic design spectra / site response spectra values or specific spectral accelerations (document only calls for compliance with IS 1893; no spectra provided).

• As-built stiffness (nozzle/branch piping) or vendor nozzle stiffness data and flange stiffness data — not provided.

• Connection weld/bolt details and allowable load capacities per nozzle (document gives only minimum nozzle sizes, not connection load ratings).

• Detailed wind drag coefficients or structural wind load factors per equipment configuration (document provides wind speeds only).

• Fabrication tolerance and as-built thickness/CA actuals for each item (document gives generic corrosion allowances, not item-specific final thicknesses).

• Obtain licensor/vendor datasheets and equipment mechanical data sheets (weights, CG, nozzle coordinates/stiffness) — document repeatedly references following licensor datasheets.

• Use listed piping stress software (Caesar / NOZZLEPRO) and ASME/ANSI codes per document for analysis.

• Confirm battery-limit pressures/temperatures and finalize design pressure margins per the document's design pressure table to define internal pressure load cases.

• Obtain seismic spectra per IS 1893 for the specific site response (document requires compliance but does not supply spectra).

End — strictly extracted only the specifications, measurements and client inputs that are explicitly stated in the submitted document and that are relevant to Nozzle Load Analysis.

End of Engineering Analysis Report